CLAIMS

1. A method of preparing at least one ester polyol, comprising esterifying at least one ozone acid with at least one primary polyol to produce an ester polyol.

2. A method of preparing at least one ester polyol according to claim 1, wherein the at least one primary polyol comprises at least one branched primary polyol.

3. A method of preparing at least one ester polyol according to claim 1 or claim 2, wherein the at least one primary polyol comprises at least one unbranched primary alcohol.

4. A method of preparing an ester polyol ester, the method comprising preparing an ester polyol according to any one of claims 1 to 3, and further esterifying the ester polyol with at least one carboxylic acid to produce at least one ester polyol ester.

5. A method of preparing a foam, the method comprising preparing an ester polyol ester according to claim 4, and further reacting the ester polyol ester with at least one compound selected from an petroleum polyol, a cross-linking agent, a cell opening additive and an isocyanate, or a mixture thereof.

6. The method according to any one of the preceding claims, wherein the method comprises esterifying the ozone acid(s) with at least two primary polyols.

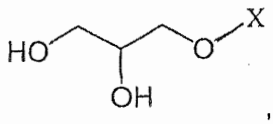
7. The method according to claim 6, wherein the method comprises esterifying the ozone acid(s) with at least two branched primary polyols.

8. The method according to claim 6 or claim 7, wherein the method comprises esterifying the ozone acid(s) with at least two unbranched primary polyols.

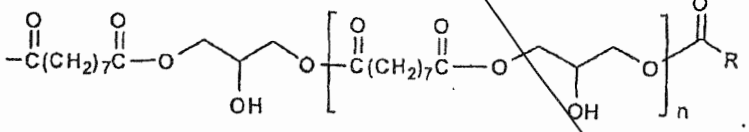
9. The method according to any one of the preceding claims, wherein the primary polyol comprises at least one unbranched primary polyol selected from glycerol, sorbitol, xylitol and erithritol and a mixture of two or more thereof.

10. The method according to claim 9, wherein the method comprises the use of glycerol and sorbitol or a mixture thereof.

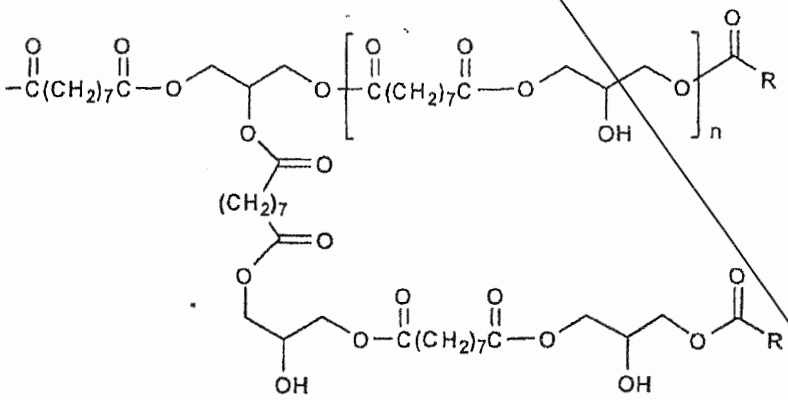
11. The method according to claims 9 or 10, wherein the at least one ester polyol comprises one or more ester polyols having the formula of:



wherein X =  ;



; or



; and

R is selected from palmitate, stearate, hexanoate, pelargonate, propionate monoesters and azelate diesters, wherein n is from 1 to 3

12. The method according to any one of the preceding claims, wherein the polyol comprises a branched primary polyol selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG) and a mixture thereof.

13. The method according to any one of the preceding claims, wherein the polyol comprises a branched primary polyol from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

14. The method according to any one of the preceding claims, wherein the polyol comprises branched primary polyols comprising trimethylolpropane (TMP).

15. The method according to any one of claims 1, 2, 4 to 7 and 12 to 14, wherein the method comprises esterifying the ozone acid(s) with at least two branched primary polyols and wherein the at least two branched primary polyols comprise 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

16. The method according to any one of the preceding claims, wherein the at least one ester polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

17. The method according to any one of the preceding claims, wherein the at least one ozone acid comprises a mixture of ozone acids.

18. The method according to any one of the preceding claims, wherein the at least one ozone acid and at least one polyol comprise a reaction mixture, wherein the at least one ozone acid has at least one carboxyl group and the at least one polyol has at least two hydroxyl groups, a ratio of the at least two hydroxyl groups to the at least one carboxyl group being a hydroxyl/carboxyl ratio, and wherein the method comprises decreasing the hydroxyl/carboxyl ratio of thereaction mixture to decrease a hydroxyl value of the ester polyol.

19. The method according to claim 18, wherein the reaction mixture has a hydroxyl to carboxyl ratio of about 2.5 or greater.

20. The method according to any one of the preceding claims, wherein the ester polyol has a hydroxyl value (HV) ranging from about 250 (mg KOH/g) to about 400 (mg KOH/g).

21. The method according to claim 18, wherein the reaction mixture has a hydroxyl to carboxyl ratio of about 1.10.

22. The method according to any one of claims 1 to 19 or 21, wherein the ester polyol has a hydroxyl value (HV) ranging from about 50 (mg KOH/g) to about 150 (mg KOH/g).

23. An ester polyol, wherein the ester polyol comprises the reaction product of:
at least one ozone acid; and
at least one primary polyol.

24. An ester polyol according to claim 23, wherein the at least one primary polyol is at least one branched primary polyol.

25. The ester polyol according to claim 24, wherein the branched primary polyol is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG); and a mixture thereof.

26. The ester polyol according to any one of claims 24 or 25, wherein the branched primary polyol(s) is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

27. The ester polyol according to any one of claims 24 to 26, wherein the at least one branched primary polyol comprises trimethylolpropane (TMP).

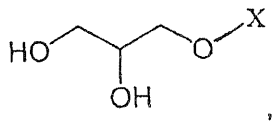
28. The ester polyol according to any one of claims 24 to 27, wherein the at least one branched primary polyol comprises 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

29. An ester polyol according to any one of claims 23 to 28, wherein the at least one primary polyol is at least one unbranched primary polyol.

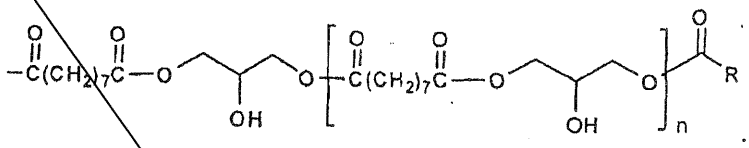
30. The ester polyol according to claim 29, wherein the at least one unbranched primary polyol is selected from glycerol, sorbitol, xylitol and erithritol and a mixture of two or more thereof.

31. The ester polyol according to claim 30, wherein the at least one unbranched primary polyol is selected from glycerol and sorbitol, or a mixture thereof.

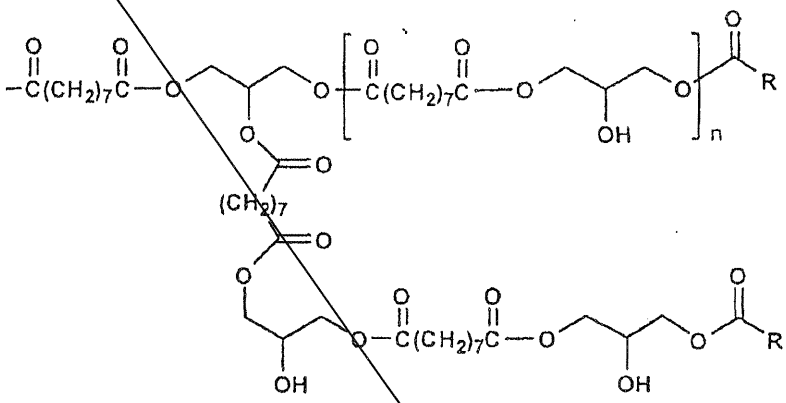
32. An ester polyol, wherein the ester polyol has the formula of:



wherein X =



; or



; and

R is selected from palmitate, stearate, hexanoate, pelargonate, propionate monoesters and azelate diesters, wherein n is from 1 to 3.

33. The ester polyol according to any one of claims 23 to 32, wherein the ester polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

34. An ester polyol ester obtainable or obtained according to the method of claim 4 or 6 to 22.

35. A foam obtained or obtainable according to the method of any one of claims 5 to 22.

36. A foam, wherein the foam is prepared from an ester polyol according to any one of claims 23 to 33 and/or an ester polyol ester according to claim 34.

37. A foam, wherein the foam comprises the reaction product of:
at least one ozone acid; and
at least one primary polyol.

38. A foam according to claim 37, wherein the at least one primary polyol is at least one branched primary polyol.

39. A foam according to claim 37, wherein the at least one primary polyol is at least one unbranched primary polyol.

40. The foam according to any one of claims 35 to 39, having a tensile strength measured at about 9.7 (psi) to about 36.9 (psi).

41. The foam according to any one of claims 35 to 39, having has a tensile strength measured at about 7.75 (psi) to about 11.55 (psi).

42. The foam according to any one of claims 35 to 41, wherein the ester polyol is in an amount of about 10% to about 100% and the petroleum polyol is an amount of about 90% to about 0%.

43. The foam according to any one of claims 35 to 42, wherein the polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

44. The foam according to any one of claims 35 to 43, wherein the foam has a free rise density from about 2.1 (pcf) to 2.6 (pcf).

45. The foam according to any one of claims 35 to 44, wherein the ester polyol is in an amount of about 10% and the petroleum polyol component is in an amount of about 90%.

46. The foam according to any one of claims 35 to 44, wherein the ester polyol is in an amount of about 20% and the petroleum polyol component is in an amount of about 80%.

47. The foam according to any one of claims 35 to 46, wherein the ester polyol has a hydroxyl value (HV) ranging from about 250 (mg KOH/g) to about 400 (mg KOH/g).

48. The foam according to any one of claims 35 to 47, wherein the foam is a rigid foam.

49. The foam according to any one of claims 35 to 47, wherein the foam has a Free Rise Density of about 2.1 (pcf) to about 2.3 (pcf).

50. The foam according to any one of claims 35 to 44 or 47 to 49, wherein the ester polyol is in an amount of about 50% and the petroleum polyol component is in an amount of about 50%.

51. The foam according to any one of claims 35 to 46 or 49 to 50, wherein the ester polyol has a hydroxyl value (HV) ranging from about 50 (mg KOH/g) to about 150 (mg KOH/g).

52. The foam according to any one of claims 35 to 44 or 47 to 49, wherein the ester polyol is in an amount of about 90% and the petroleum polyol component is in an amount of about 10%.

53. The foam according to any one of claims 35 to 44 or 47 to 49, wherein the ester polyol is in an amount of about 100% and the petroleum polyol component is in an amount of about 0.0%.

54. The foam according to any one of claims 35 to 53, wherein the foam has a density of about 2.4 (pcf) to about 2.5 (pcf).

55. The foam according to any one of claims 35 to 54, wherein the foam has a thermal conductivity (K-factor) of about 0.148 to about 0.154.

56. The foam according to any one of claims 35 to 55, wherein the foam has a maximum load of about 5.50% to 6.25%.

57. The foam according to any one of claims 35 to 39 or 42 to 56, wherein the foam has a tensile strength of about 9.7 (psi) to about 13.5 (psi).

58. The foam according to any one of claims 35 to 57, wherein the foam has an elongation at a break measured at about 78.3% to about 118.5%.

59. The foam according to any one of claims 35 to 58, wherein the foam has a resiliency of about 23.1 to 59.0%.

60. The foam according to any one of claims 35 to 46 or 49 to 59, wherein the foam is a flexible foam.

61. The foam according to any one of claims 35 to 48 or 50 to 60, wherein the foam has a Free Rise Density of about 2.3 (pcf) to about 2.6 (pcf).

62. The foam according to any one of claims 35 to 58 or 60 to 61, wherein the foam has a ball Resilience (16mm) with a Rebound percentage of about 23.1% to about 59.0%.

63. The foam according to any one of claims 35 to 62, comprising at least one cell opening additive; and at least one isocyanate.

64. The foam according to any one of claims 35 to 64, further comprising at least one cross-linking agent comprising at least one branched primary polyol selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG); and at least one isocyanate.

65. The foam according to claim 64, wherein the branched primary polyol(s) is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

66. The foam according to claim 64, wherein the at least one branched primary polyol comprises trimethylolpropane (TMP).

67. The foam according to claim 64, wherein the at least one branched primary polyol comprises 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

68. A polyurethane coating, prepared using the ester polyol according to any one of claims 24 to 33.

69. A method of reducing the separation of a composition comprising at least one ester polyol in a single phase into two or more phases, the method comprising esterifying at least one ozone acid with at least one primary polyol to produce the at least one ester polyol, thereby reducing the phase separation of the at least one ester polyol.

70. The method of claim 69, wherein the at least one primary polyol comprises at least one branched polyol.

71. The method of claim 69 or claim 70, wherein the at least one primary polyol comprises at least one unbranched polyol.

72. The method according to claim 69, wherein the composition is in a single liquid phase.

73. The method according to claim 70, wherein the at least one ester polyol does not substantially separate into more than one phase.

74. The method according to claim 70, wherein the composition is let allow to achieve to the temperature range from about 20°C to about 80°C.

75. A polyol ester prepared by reacting azelaic acid and pelargonic acid, optionally from tallow or palm feedstocks, with:
(a) glycerin and sorbitol;
(b) glycerin and 2-methyl-1,3-propanediol, or
(c) 2-methyl-1,3-propanediol and TMP, optionally wherein
the approximate molar equivalents of the reactants are as listed in Tables 100 or 400 of the description.

76. The polyol ester of claim 75, wherein:
(i) in the reaction mixture for (a) of claim 75 azelaic acid is present in 27.91 wt%, pelargonic acid is present in 29.86 wt%, sorbitol is present in 15.73 wt% and glycerol is present in 26.51 wt%;
(ii) in the reaction mixture for (b) of claim 75 azelaic acid is present in 33.72 wt%, pelargonic acid is present in 43.18 wt%, 2-methyl-1,3-propanediol is present in 3.52 wt% and glycerol is present in 19.58 wt%; and

(iii) in the reaction mixture for (b) of claim 75 azelaic acid is present in 29.86 wt%, pelargonic acid is present in 31.32 wt%, 2-methyl-1,3-propanediol is present in 11.03 wt% and TMP is present in 27.79 wt%.

CLAIMS

1. A method of preparing at least one ester polyol, comprising esterifying at least one ozone acid with at least one primary polyol to produce an ester polyol, wherein the at least one primary polyol comprises at least two branched primary polyols and the method comprises esterifying the ozone acid(s) with at least two branched primary polyols.

2. A method of preparing at least one ester polyol according to claim 1, wherein the at least one primary polyol comprises at least one unbranched primary alcohol.

3. A method of preparing an ester polyol ester, the method comprising preparing an ester polyol according to any one of claims 1 to 2, and further esterifying the ester polyol with at least one carboxylic acid to produce at least one ester polyol ester.

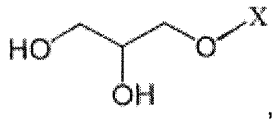
4. A method of preparing a foam, the method comprising preparing an ester polyol ester according to claim 3, and further reacting the ester polyol ester with at least one compound selected from an petroleum polyol, a cross-linking agent, a cell opening additive and an isocyanate, or a mixture thereof.

5. The method according to claim 1, wherein the method comprises esterifying the ozone acid(s) with at least two unbranched primary polyols.

6. The method according to any one of the preceding claims, wherein the primary polyol comprises at least one unbranched primary polyol selected from glycerol, sorbitol, xylitol and erithritol and a mixture of two or more thereof.

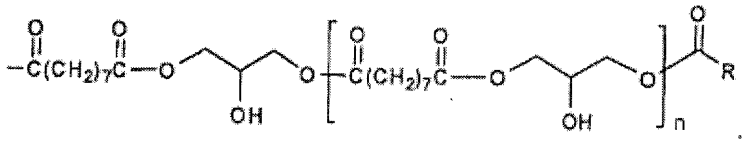
7. The method according to claim 6, wherein the method comprises the use of glycerol and sorbitol or a mixture thereof.

8. The method according to claim 6, wherein the at least one ester polyol comprises one or more ester polyols having the formula of:

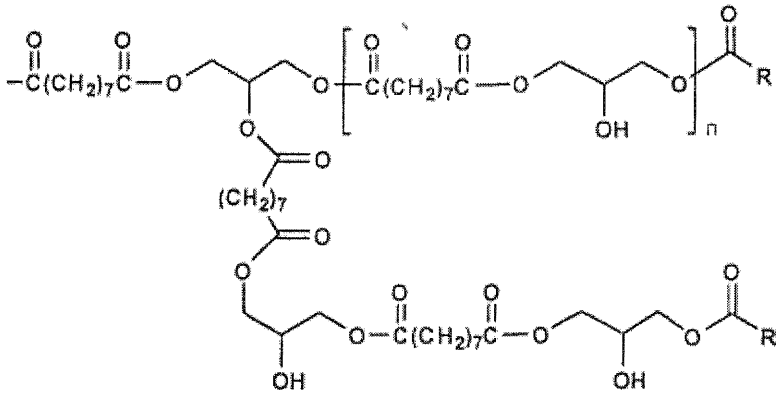


,

wherein X =  ;



; or



; and

R is selected from palmitate, stearate, hexanoate, pelargonate, propionate monoesters and azelate diesters, wherein n is from 1 to 3

9. The method according to any one of the preceding claims, wherein the polyol comprises a branched primary polyol selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG) and a mixture thereof.

10. The method according to any one of the preceding claims, wherein the polyol comprises a branched primary polyol from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

11. The method according to any one of the preceding claims, wherein the polyol comprises branched primary polyols comprising trimethylolpropane (TMP).

12. The method according to any one of claims 1, 3 to 4 and 9 to 11, wherein the at least two branched primary polyols comprise 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

13. The method according to any one of the preceding claims, wherein the at least one ester polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

14. The method according to any one of the preceding claims, wherein the at least one ozone acid comprises a mixture of ozone acids.

15. The method according to any one of the preceding claims, wherein the at least one ozone acid and at least one polyol comprise a reaction mixture, wherein the at least one ozone acid has at least one carboxyl group and the at least one polyol has at least two hydroxyl groups, a ratio of the at least two hydroxyl groups to the at least one carboxyl group being a hydroxyl/carboxyl ratio, and wherein the method comprises decreasing the hydroxyl/carboxyl ratio of the reaction mixture to decrease a hydroxyl value of the ester polyol.

16. The method according to claim 15, wherein the reaction mixture has a hydroxyl to carboxyl ratio of about 2.5 or greater.

17. The method according to any one of the preceding claims, wherein the ester polyol has a hydroxyl value (HV) ranging from about 250 (mg KOH/g) to about 400 (mg KOH/g).

18. The method according to claim 15, wherein the reaction mixture has a hydroxyl to carboxyl ratio of about 1.10.

19. The method according to any one of claims 1 to 16 or 18, wherein the ester polyol has a hydroxyl value (HV) ranging from about 50 (mg KOH/g) to about 150 (mg KOH/g).

20. An ester polyol, wherein the ester polyol comprises the reaction product of:
at least one ozone acid; and
at least one primary polyol,
wherein the at least one primary polyol comprises at least two branched primary polyols.

21. The ester polyol according to claim 20, wherein the branched primary polyol is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG); and a mixture thereof.

22. The ester polyol according to claim 21, wherein the branched primary polyol(s) is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

23. The ester polyol according to any one of claims 21 to 22, wherein at least one of the branched primary polyols is trimethylolpropane (TMP).

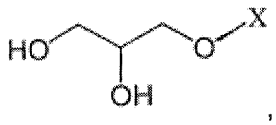
24. The ester polyol according to any one of claims 21 to 23, wherein the branched primary polyols are 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

25. An ester polyol according to any one of claims 20 to 24, wherein the at least one primary polyol comprises at least one unbranched primary polyol.

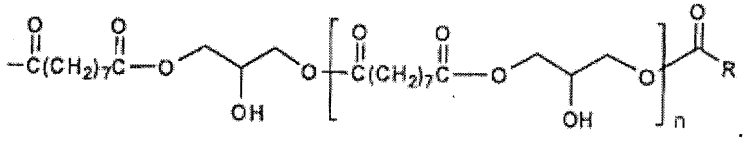
26. The ester polyol according to claim 25, wherein the at least one unbranched primary polyol is selected from glycerol, sorbitol, xylitol and erithritol and a mixture of two or more thereof.

27. The ester polyol according to claim 26, wherein the at least one unbranched primary polyol is selected from glycerol and sorbitol, or a mixture thereof.

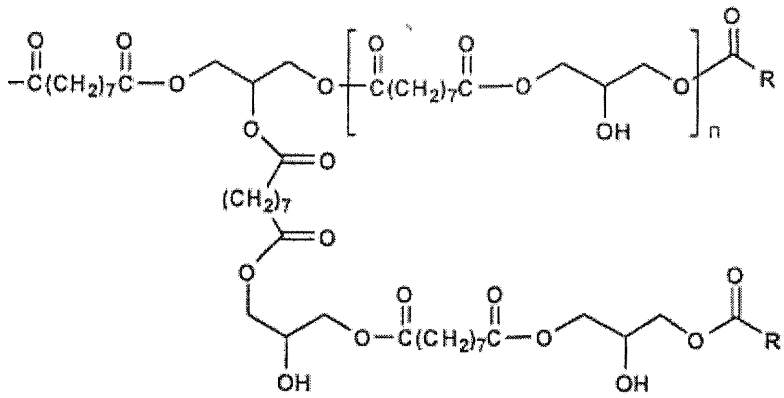
28. An ester polyol, wherein the ester polyol has the formula of:



wherein X =



; or



; and

R is selected from palmitate, stearate, hexanoate, pelargonate, propionate monoesters and azelate diesters, wherein n is from 1 to 3.

29. The ester polyol according to any one of claims 20 to 28, wherein the ester polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

30. An ester polyol ester obtainable or obtained according to the method of claim 3 or 5 to 19.

31. A foam obtained or obtainable according to the method of any one of claims 4 to 19.

32. A foam, wherein the foam is prepared from an ester polyol according to any one of claims 20 to 29 and/or an ester polyol ester according to claim 30.

33. A foam, wherein the foam comprises the reaction product of:
at least one ozone acid; and
at least one primary polyol, wherein the at least one primary polyol comprises at least two branched primary polyols.

34. A foam according to claim 33, wherein the at least one primary polyol comprises at least one unbranched primary polyol.

35. The foam according to any one of claims 31 to 34, having a tensile strength measured at about 9.7 (psi) to about 36.9 (psi).

36. The foam according to any one of claims 31 to 34, having has a tensile strength measured at about 7.75 (psi) to about 11.55 (psi).

37. The foam according to any one of claims 31 to 36, wherein the ester polyol is in an amount of about 10% to about 100% and the petroleum polyol is an amount of about 90% to about 0%.

38. The foam according to any one of claims 31 to 37, wherein the polyol has a hydroxyl value (HV) from about 20 (mg KOH/g) to about 450 (mg KOH/g).

39. The foam according to any one of claims 31 to 38, wherein the foam has a free rise density from about 2.1 (pcf) to 2.6 (pcf).

40. The foam according to any one of claims 31 to 39, wherein the ester polyol is in an amount of about 10% and the petroleum polyol component is in an amount of about 90%.

41. The foam according to any one of claims 31 to 39, wherein the ester polyol is in an amount of about 20% and the petroleum polyol component is in an amount of about 80%.

42. The foam according to any one of claims 31 to 41, wherein the ester polyol has a hydroxyl value (HV) ranging from about 250 (mg KOH/g) to about 400 (mg KOH/g).

43. The foam according to any one of claims 31 to 42, wherein the foam is a rigid foam.

44. The foam according to any one of claims 31 to 42, wherein the foam has a Free Rise Density of about 2.1 (pcf) to about 2.3 (pcf).

45. The foam according to any one of claims 31 to 39 or 42 to 44, wherein the ester polyol is in an amount of about 50% and the petroleum polyol component is in an amount of about 50%.

46. The foam according to any one of claims 31 to 41 or 44 to 55, wherein the ester polyol has a hydroxyl value (HV) ranging from about 50 (mg KOH/g) to about 150 (mg KOH/g).

47. The foam according to any one of claims 31 to 39 or 42 to 44, wherein the ester polyol is in an amount of about 90% and the petroleum polyol component is in an amount of about 10%.

48. The foam according to any one of claims 31 to 39 or 42 to 44, wherein the ester polyol is in an amount of about 100% and the petroleum polyol component is in an amount of about 0.0%.

49. The foam according to any one of claims 31 to 48, wherein the foam has a density of about 2.4 (pcf) to about 2.5 (pcf).

50. The foam according to any one of claims 31 to 49, wherein the foam has a thermal conductivity (K-factor) of about 0.148 to about 0.154.

51. The foam according to any one of claims 31 to 50, wherein the foam has a maximum load of about 5.50% to 6.25%.

52. The foam according to any one of claims 31 to 34 or 37 to 51, wherein the foam has a tensile strength of about 9.7 (psi) to about 13.5 (psi).

53. The foam according to any one of claims 31 to 52, wherein the foam has an elongation at a break measured at about 78.3% to about 118.5%.

54. The foam according to any one of claims 31 to 53, wherein the foam has a resiliency of about 23.1 to 59.0%.

55. The foam according to any one of claims 31 to 41 or 44 to 54, wherein the foam is a flexible foam.

56. The foam according to any one of claims 31 to 43 or 45 to 55, wherein the foam has a Free Rise Density of about 2.3 (pcf) to about 2.6 (pcf).

57. The foam according to any one of claims 31 to 53 or 55 to 56, wherein the foam has a ball Resilience (16mm) with a Rebound percentage of about 23.1% to about 59.0%.

58. The foam according to any one of claims 31 to 57, comprising at least one cell opening additive; and at least one isocyanate.

59. The foam according to any one of claims 31 to 58, further comprising at least one cross-linking agent comprising at least one branched primary polyol selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); pentaerythritol (PE); dipentaerythritol diPE); neopentyl glycol (NPG); and at least one isocyanate.

60. The foam according to claim 59, wherein the branched primary polyol(s) is selected from 2-methyl-1,3-propanediol (2-MePG); trimethylolpropane (TMP); di-trimethylolpropane (Di-TMP); neopentyl glycol (NPG) and a mixture thereof.

61. The foam according to claim 59, wherein the at least two branched primary polyols comprises trimethylolpropane (TMP).

62. The foam according to claim 59, wherein the at least two branched primary polyols comprises 2-methyl-1,3-propanediol (2-MePG) and trimethylolpropane (TMP).

63. A polyurethane coating, prepared using the ester polyol according to any one of claims 20 to 29.

64. A method of reducing the separation of a composition comprising at least one ester polyol in a single phase into two or more phases, the method comprising esterifying at least one ozone acid with at least one primary polyol to produce the at least one ester polyol, thereby reducing the phase separation of the at least one ester polyol, wherein the at least one primary polyol comprises at least two branched primary polyols.

65. The method of claim 64, wherein the at least one primary polyol comprises at least one unbranched polyol.

66. The method according to claim 64, wherein the composition is in a single liquid phase.

67. The method according to claim 64, wherein the at least one ester polyol does not substantially separate into more than one phase.

68. The method according to claim 64, wherein the composition is let allow to achieve to the temperature range from about 20°C to about 80°C.